Field Studies for the Conservation and Management of Point Calimere Complex

Dr. Rauf Ali

Foundation for Ecological Research, Advocacy and Learning

FIELD STUDIES FOR THE CONSERVATION AND MANAGEMENT OF POINT CALIMERE COMPLEX

A REPORT FOR THE TAMIL NADU FOREST DEPARTMENT

Dr. Rauf Ali

Email for correspondence: rauf@feralindia.org

FOUNDATION FOR ECOLOGICAL RESEARCH, ADVOCACY AND LEARNING (FERAL)
P.O.BOX 28, PONDICHERRY-605 001

Abstract

A survey of Point Calimere Wildlife sanctuary was done between December 2004 and May 2005. Various ecological aspects of the sanctuary were examined.

- The most important finding is that ***Prosopis*** **is now a problem weed** destroying both tropical dry everygreen forest critical to birds and coastal grasslands critical to a healthy blackbuck population. This threat needs to be eliminated. This can be done in a manner as to benefit landless people living on the fringes of the sanctuary.

- **Line transects are a more efficient way of estimating animal numbers** in the park than the existing method of total counts.

- **Hypersalinity in the salt pans, in the areas surrounding the park will likely affect the bird populations negatively** since the marine organisms lower in the food chain may not be able to survive in them. This becomes a priority study for future action.

A CD is supplied with this report that contains background reading on line transects and digital copies of the maps generated for this report. It also has LANDSAT imagery for the sanctuary for 1978, 1991 and 1999. These can be viewed using MULTISPEC, a freeware available on the Internet; we recommend that the latest available version be downloaded.

Acknowledgements

I thank the Tamil Nadu Forest Department for funding this study. Mr. Akash Baruah, IFS extended all the help and facilities required to execute this project.

Dr. Balachandran of BNHS opened my eyes to the problems of hypersalinity. Persons who have contributed significantly to this report include Srinivas. V, Gopinath. S, Paco Prieto, Gaspard Appavou, Saravanan. S, Karthikeyan, Shymal, Ravi Bhalla, Dilip Venugopal and; Steven Beck, Alex Craun, Gaia Eirich, Holly Gabries, Mariel Marlow, Lynn Rassel, and Scott Sakowski of Juniata College. Prof. Neil Pelkey from Juniata College and Dr. M. B. Krishna provided major inputs into this report. Our field assistants from KMTR Ashok, Kamal, Jaikumar and Selvakumar helped in data collection.

Introduction

Point Calimere, along with the associated Panchanadikulam wetland and the Muthupet mangroves, was declared a Ramsar site in August 2002. Since the background to this is known, details are not furnished here (Islam & Rahmani, 2004)[1]. After the declaration, work was initiated under a Centrally sponsored scheme entitled "Conservation and Management of Point Calimere Wetland Complex". Under which field studies were conducted on vegetation, water birds and wildlife of the Ramsar site for better understanding of important habitat parameters and formulation of future management strategies. These studies covered important aspects of the above, and prescribe future courses of action.

The forests of Point Calimere, in Nagapattinam District of Tamil Nadu, were notified as the Kodikkadu RF and the Kodikaddu Extension RF in 1907. These comprised an area of 1729 ha. There are two villages in the area, Kodikkarai and Kodiakaddu, about 11 Km south of Vedaranyam town. In June 1967, the Point Calimere Wildlife Sanctuary was notified with an area of 2147 ha. The sanctuary derives its name from a outcrop into the sea called Point Calimere, where the coastline makes a 90^{o} turn, marking the boundary between the Bay of Bengal and the Palk Strait. In 1988, the Great Vedaranyam Swamp and the Talaignayar RF were added to form the proposed Point Calimere Wildlife Sanctuary, comprising an area of 37,733 ha.

The sanctuary is located between the coordinates of 10^{o}18'N, 79^{o}51'E and 10^{o}21'N, 79^{o}25'E. The original sanctuary is on coastal plains, with a mixture of Tropical Dry Evergreen Forest, mudflats, grassland, backwaters and sand dunes. West of this, the Great Vedaranyam Swamp extends 48 Km towards Muthupet town. It is fringed with mangrove vegetation. There are also many saltpans adjoining the Sanctuary.

[1] Islam, M.Z. & A.R. Rahmani(2004) Important Bird Areas in India: Priority sites for conservation. International Bird Conservation Network: BNHS and BirdLife International. Pp. xviii+ 1133.

The tropical dry evergreen forests here are among the best preserved anywhere of this almost extinct forest type. These forests exist in spite of a rainfall of only 1250 mm per annum. These forests once existed all along the Coromandel Coast. *Lannea coromandelica* which is an introduced species is the only deciduous species found in this forest. *Manilkara hexandra* is the dominant tree species. In total, 317 flowering plants have been identified from inside the park (Baruah, *pers. comm.)* These include two species of *Drocera*, an insectivorous plant.

The dominant grass in the grassland is *Aeluropus lagopoides*, followed by *Sporobulu tremulus* and *Cressa cretica.* The sand dunes are largely colonised by invasives such as *Prosopis juliflora* and *Calotropis gigantea*.

Access to the sanctuary is by road from Chennai (360 km) or from Trichy (170 km). The relative distance from airports or major rail stations reduces its high-value tourism potential substantially. However, there are a lot of local tourists who visit every weekend.

Point Calimere WLS is listed as an Important Bird Area (IBA) for India. This is because it contains about 110 species of waterbirds, of which 34 are winter migrants. In January 1987, 28,000 flamingoes and 1,00,000 Garganey Teal were recorded during a census. Many species of ducks and waders occur in numbers that are greater than 1% of their population, meeting the Wetlands International criterion for IBA's.(Islam & Rahmani, 2004).[2]

Endangered bird species include Spotted Greenshank (*Tringa guttifer*). The Vulnerable species found here include the Spotbilled Pelican (*Pelecanus philippensis*), Spoonbilled Sandpiper (*Calidris pygmeus*) and the Broad-tailed Grass Warbler (*Schoenicola platyura*). Near Threatened species include Darter (*Anhinga melanogaster*), Painted Stork (*Mycteria leucocephala*), Black-Necked Stork (*Ephippiorhynchus asiaticus*), Oriental White Ibis (*Threskiornis melanocephala*) Lesser Flamingo ((*Phoenicopterus minor*) and Pallid Harrier (*Circus macrourus*) (Islam & Rahmani, 2004).

[2] Islam, M.Z. & A.R. Rahmani(2004) Important Bird Areas in India: Priority sites for conservation. International Bird Conservation Network: BNHS and BirdLife International. Pp. xviii+ 1133.

Mammals reported from the park include the Blackbuck (*Antilope cervicapra*). The presence of the endangered blackbuck was the primary motivation in setting up the wildlife sanctuary in 1967, and the population was about 600 then. Other animals include Chital (*Axis axis*), Wild Boar (*Sus scrofa*), and Jackal (*Canis aureus*). Horses have gone feral inside the park as well, having been introduced there over a hundred years ago, when they were used for transporting goods along the coast. Bottlenosed dolphins are common off the coast, and whale strandings occur occasionally in the area. Recently a Bryde's Whale was successfully rescued from here.

The coastline is a regular nesting place for Olive Ridley Turtles, and hatcheries have been set up since 1985. Even after the tsunami of December 2004, turtles continued to lay eggs, and 169 hatchlings were released in April 2005.

Industrialisation of the swamp due to salt pans, and firewood collection have been identified in the past as threats to the park (Islam & Rahmani, 2004). Currently the presence of salt pans and spread of *Prosopis* are two important threats to the park.

Objectives of the study

The objectives of this study were:

- To prepare a land cover map of the sanctuary area and its surroundings using available satellite imagery and to give details of land use patterns in the area.
- To build profiles of salinity and pH of water over the area, and correlate this to habitat usage by birds.
- To look at different vegetation communities and identify changes in vegetation health, with specific reference to the problems caused by the invasive *Prosopis juliflora.*
- Enumeration of flora at selected sites.
- Census of mammals in the park.
- To conduct socio-economic surveys in the human habitations around the park to assess levels of dependence upon the park.

Land Cover

Objective

The objective of the land cover mapping was to produce a detailed map showing the different land cover and land use patterns in and around the park.

Methodology

The November 11, 1999 LANDSAT ETM imagery for the area was obtained for the mapping exercise. The imagery has a spatial resolution of 28.5 X 28. 5m. This image was orthorectified and georeferenced. The image was georeferenced using ground control points provided along with the dataset. The image was reprojected to UTM before further analysis could be undertaken. A 1991 LANDSAT (January 29th, 1991) was also obtained and similar steps were undertaken. The 1991 image was not used for classification as it was difficult to ascertain the exact vegetation condition 14 years ago. Only the 1999 image has been used. It has been assumed that there has been little loss or change between 1999 – 2005.

Based on reconnaissance surveys we identified seven broad categories of land cover representing Prosopis, Saltpans, Tropical Dry Evergreen Forests, Sand (Coastal and Inland), Water (Fresh and Saline) and open lands. The last category includes grassland, scrub, and any open soil with or without vegetation. Hand held GPS units with an accuracy of about 8m were used to collect training sites for image classification. Twenty training sites per land cover category were collected.

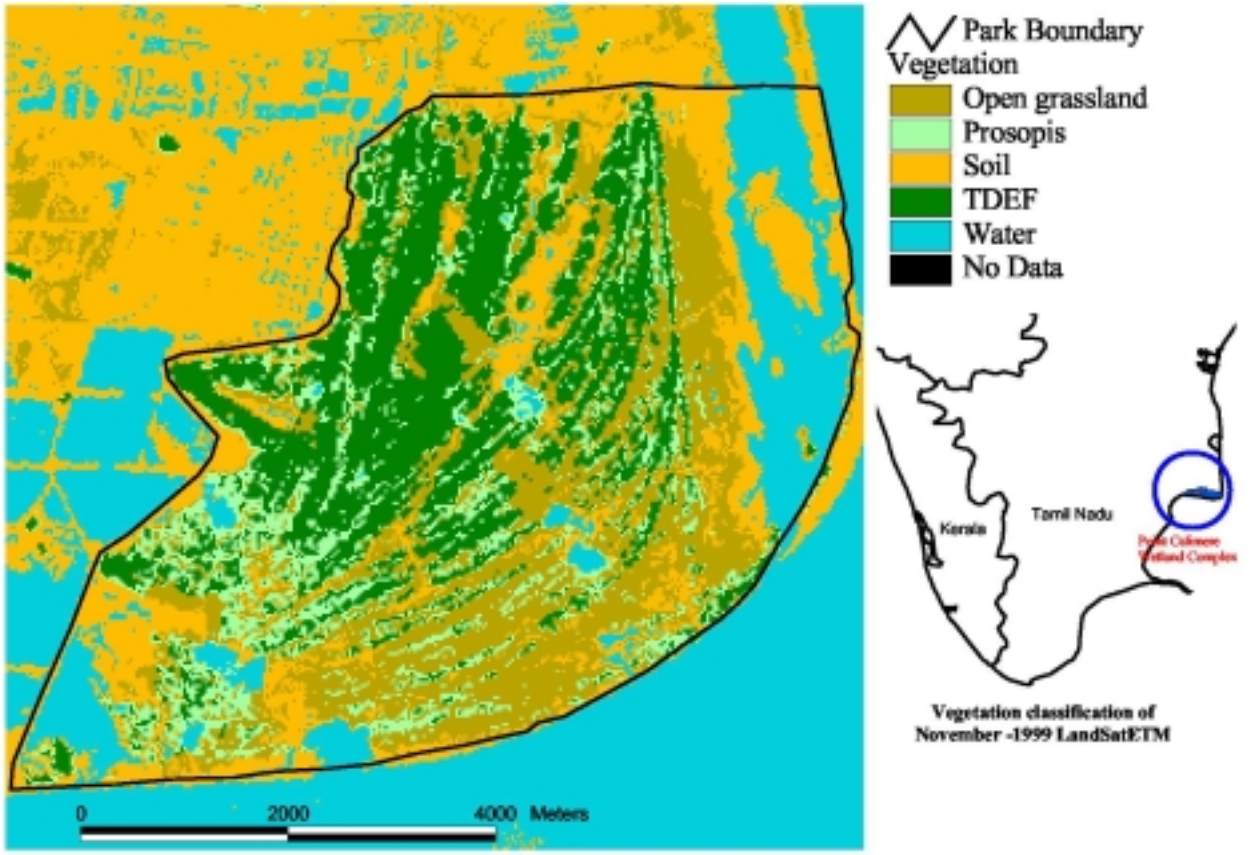
Of the seven bands of satellite data that was available only bands 1-5 were used for vegetation classification. The image was classified using Minimum distance, Parallel piped and Maximum likelihood estimators. Of the three, the results obtained from the Maximum likehood classification were more realistic. The final vegetation map was prepared using Maximum Likelihood estimator, where in prior probability values for each land cover category provided. The probability values for each category was assigned proportional to the area occupied by that category through out the study area. For example if open lands formed about 40% of the study area the probability value associated with this category was 0.4. Also to improve results an additional band of NDVI was used to develop signatures for the training sites. The data was analysed using IDRISI[3] and the final map was prepared using ArcView 3.2[4]

Results and discussion.

KEY FINDING: *Prosopis juliflora* has taken over a large part of the sanctuary.

A land cover map is given below. It was created using maximum likelihood supervised classification using approximately 20 ground control points for each habitat type. Although 20 training sites per category were used to classify the image, there was considerable difficulty in clearly distinguishing between *Prosopis* and young/degraded mangrove and Prosopis and degraded TDEF. This problem can be overcome by using more than one season image as different vegetation types have different levels of moisture and greenness during the dry season. Additional field data related to disturbance levels can be used to refine the final vegetation map. These could not be carried out given the scope of this study. Although not a priority we recommend that such studies be carried out in the future.

[3] Eastman J. R. (2001) Idrisi32 Release 2. Clark Labs, Clark University.
[4] Environmental System Research Institute (2002) ArcView GIS Version 3.2

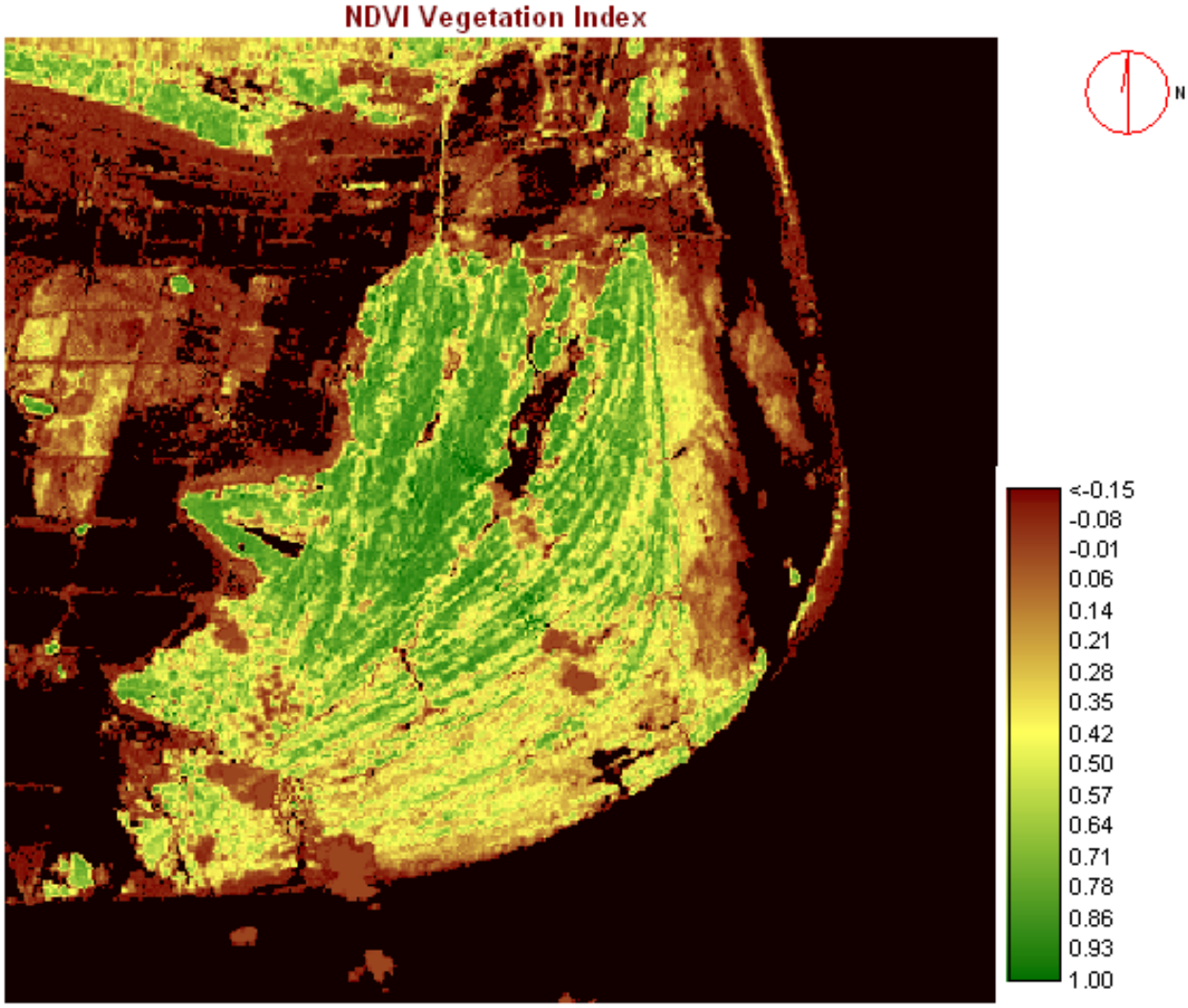


Prosopis has invaded both the TDEF in the Kodikkarai area, as well as the mangroves near Muthupet. It has taken over expanses near the coast. It is seen that there are large waterbodies along the coast from Kodikkarai to Muthupet. This raises the possibility of tourism in the form of boat cruises in this area, which would visit the mangrove areas (not seen in this map).

Legal status of the open areas in the middle of the figure is not known. If these are un-encroached revenue land, land consolidation and plantation activity is a possibility.

Using the Normalised Differential Vegetation Index (NDVI), we assessed the vegetation cover throughout the park. This is derived from satellite imagery and measures the amount of chlorophyll present at any point. The higher the index the more the vegetation there is, relative to the other points near it. An NDVI map is given below. NDVI values greater than 0 imply that some green vegetation is present.

Figure 1 NDVI values for Point Calimere, values above zero represent vegetation and those below represent no vegetated areas. Higher NDVI values indicate greener vegetation types



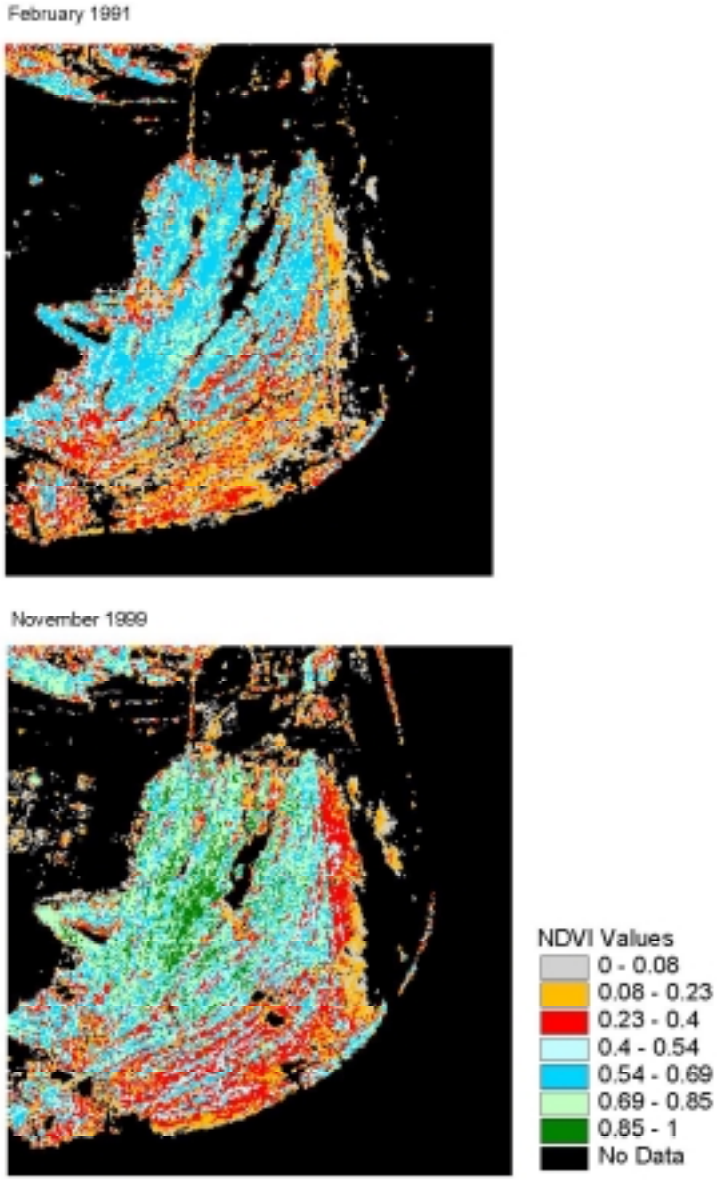
A comparison of the NDVI map with the vegetation classification shows that the *Prosopis* areas tend to have a lower NDVI than the areas covered by TDEF (refer to Table 1) We may therefore use the NDVI values for Prosopis as a proxy to monitor the spread of *Prosopis* within the park. This becomes necessary since there are no data points from 1991 showing the extent of the *Prosopis*.

Table 1 Comparison of NDVI values for Prosopis and TDEF, for 1991 and 1999 Landsat images

	1991		1999	
	Average NDVI	Standard Deviation	Average NDVI	Standard Deviation
Prospis	0.349	0.214	0.428	0.174
TDEF	0.588	0.130	0.657	0.122

A comparison between the 1991 and 1999 NDVIs is given below. The red represents *Prosopis* in these images. It can be seen that the area under *Prosopis* has increased considerably between these eight years. It may be noted that the images are from different months. This may be why the area under TDEF in 1999 seems more. This may be a genuine increase due to increased protection or due to more deciduous species being in leaf during this period.

Figure 2 A comparision of NDVI values for the year 1991 and 1999. Considerable increase in NDVI in the range of 0.3 - 0.5 representing Prosopis can be observed on the Eastern and South Eastern parts of the Park.



Salinity and pH of water

Objectives

To build a profile of salinity and pH of water over the area, and correlate this to habitat usage by birds.

Methodology

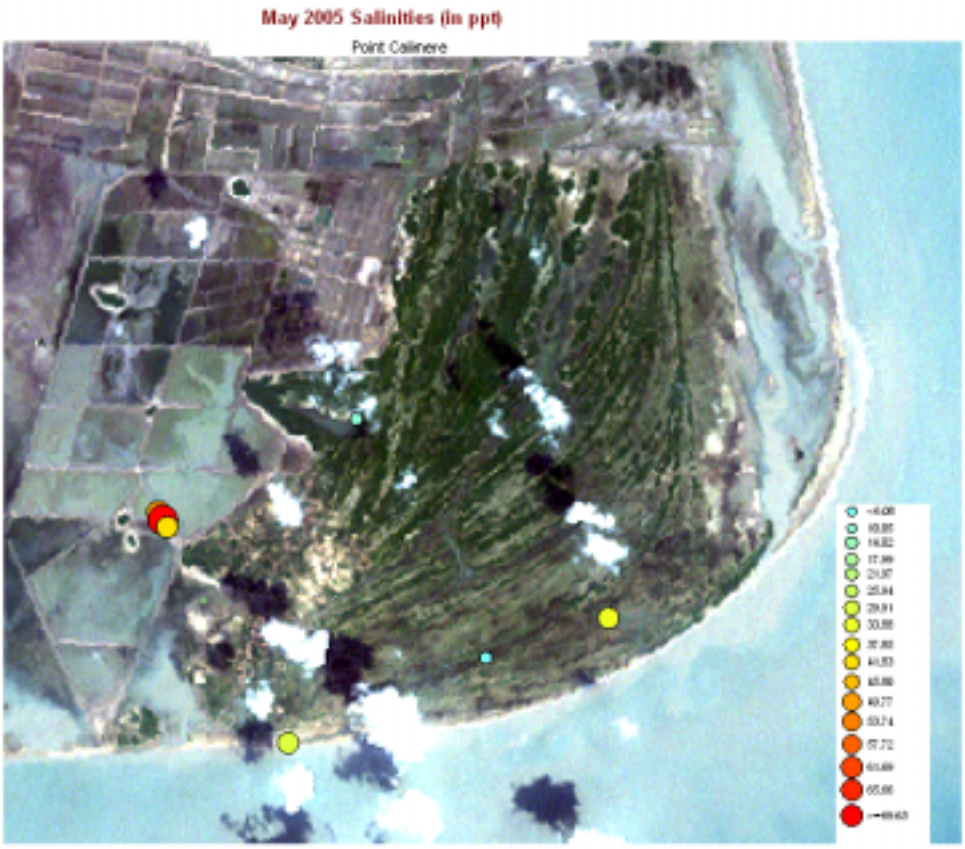
Water samples were field-tested using portable kits (manufactured by Eutech). The units were calibrated using standard buffer solutions. Parameters measured were pH, Total Dissolved Solids and Electical Conductivity. Prior to sampling a sampling design of uniformly placed sampling locations was generated on a GIS platform. The distance between the sampling locations was 1 km. But this design could not be implemented on field as most parts of the wetland complex was dry during the sampling period. Thus sampling points were chosen where ever water was available. GPS co-ordinates for each sampling location were also noted.

Results and discussion

KEY FINDING: Salinity due to the salt pans in the area poses a threat to the waterbirds congregating in the area.

Salinity was sampled in several places in the park in May 2005. Since this is the dry season, water was available at very few places. PH and turbidity data was also collected but discarded because of potential calibration problems with the sensors used. Salinity data is presented below:

Figure 3 Map showing salinity levels in water, blue dots represent fresh water and red represents highly saline waters



The yellow represents the range for seawater. Hypersalinity was noted in the saltpans near the sanctuary. Since these salt pans harbour large populations of waterbirds, studies need to be initiated immediately on how this salinity affects the polychaete worms and other invertebrates that these waterbirds feed on (Balachandran, *pers. comm*.). The Kodiakadu lake showed that the water was relatively fresh (blue point). Also water sampling needs to be carried out at these sites a least on a monthly basis. Inexpensive portable electronic meters are available for this purpose, and field staff can be easily trained in their use.

There has been a tremendous decrease in the number of waders in the salt pan area between 1980 and 2004 (Balachandran, *pers. obs*). This is an artefact of higher salinity levels due to the salt industries in the area. Thus regular and periodic monitoring of salinity levels and bird surveys becomes a priority. Also shutting down of salt industries and prioritisation for acquisition is important.

Flora

Objectives

The vegetation study seeks to build a baseline for a number of issues pertaining to plant species richness and abundance. The specific objectives of the study are:

• To develop a baseline of species abundance and richness for the sanctuary with special emphasis on spatial locations.

• To determine relative occurrence of those species with medicinal value and those unique to tropical dry ever-green forests.

• To establish a relationship between the occurrence of *Prosopis juliflora* and other native species.

Methodology

Various methods were debated to establish plant densities which included:

• A modification of the T-square method (Bullock, 1996[5]) wherein: A random point is selected (a set of random points was generated using a GIS package). A tape measure is drawn to measure the distance (x) from this point (r) to the nearest *Prosopis juliflora* tree (p). A second tape measurement is taken to the closest non-prosopis tree (n) from the point (p). Two circular quadrats are drawn around points p and n with a radius of 5 metres. All tree species within this radius are enumerated.

• Quadrats of 4x25 metres drawn in *Prosopis* and non-*Prosopis* areas. The total area covered by the quadrats should approach 2ha.

Finally a mix of techniques was decided upon to suit the unique sampling conditions prevalent in the park. The final methods followed were:

Vegetation plots:

[5] Bullock J (1996) Ecological census techniques. Eds Sutherland W. J. Cambridge University Press pp: 111-137

Some points fell within or near small clumps of vegetation. In this case the clump was mapped and all non-herbaceous species enumerated.

Some points fell near large clumps. In this case a 4x25 quadrat was drawn along the direction of the point and the clump (to ensure that the edge was not over sampled), or towards the center of the clump.

Some points fell inside large clumps. A 4x25 quadrat was drawn in a North-South direction.

Some points fell near clumps which were large enough to hold a quadrat. The quadrats were placed along the shape of the clump but to its centre so that it was not oversampling the edge.

Co-ordinates of all the sampling locations were taken along with their compass bearing and dimensions.

Two primary methods of analysis were used:

Box Plots:

This is a useful technique to study the characteristics of a single batch of numbers. The central line represents the median. The upper and lower edges of the box represent the 25% and 75% quartiles. The 'whiskers' represent the 95% confidence limits-roughly, for the purposes of this report. Points outside these whiskers are outliers. This is used in the place of means and standard deviations, which assume that the data is normally distributed. Using Box plots makes no assumptions about the underlying distribution of the data, and this technique is being used more and more frequently in biology.

Rank-Abundance curves:

All the species in the sample are ranked according to their order of abundance. The ranks are plotted along the x-axis. The y-axis has the abundances on a logarithmic or power of ten scale. Rank-abundance curves provide an alternate and more visual method of examining species diversity. Curves that extend most to the right have the most number of species. Curves that fall steeply have uneven species distributions compared to curves that do not fall steeply.

Results and discussion

KEY FINDINGS: *Prosopis* affects the species number and density of other plant species in the area, and thus reduces diversity.

A list of all plant species enumerated is provided in table 1.

Prosopis affects the presence of other species in the area: The total number of individuals in plots without *Prosopis* is higher than plots with *Prosopis* present (means 37.4 vs. 23) and this is significantly different ($t=2.031$, $p<0.05$). The total number of species is also reduced (10.6 vs 6.7) and this is also significant ($t=2.25$, $p<0.05$; this result has not been corrected for differences in area). Tree and sapling densities are much lower when *Prosopis* is present ($0.20/m^2$ vs. $0.36/m^2$), and this difference is highly significant ($t=2.77$, $p<0.01$). Table 1 provides details of the same.

Table 2 List of plant species enumerated in this study

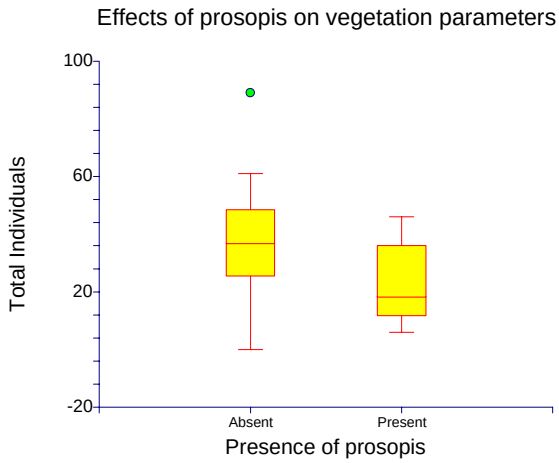
Species	*Species*	*Species*
Acretia microphylla	*Diplocyelis palmata*	*Pleurostylus oppositifolia*
Aerssia olipolis	*Dodalia asiatica*	*Pongamia pinnata*
Abrus precatarius	*Euphorbia thirucalli*	*Premna integrifolia*
Acacia cancatia	*Exoecorea acolochica*	*Prosopis juliflora*
Asparagus recemosus	*Ixora parviflora*	*Randia dumetorum*
Atalantia monophylla	*Glycosmis cochinchinensis*	*Randia malabarica*
Azima tetracantha	*Gmelina asiatica*	*Rivia kyboeateriformis*
Canthium dicoccccum	*Grewia rahamanifolia*	*Salasia primidus*
Canthium parviflorum	*Igritia microphylla*	*Salvadora persica*
Capparis ceylonica	*Hemicyclia sapheria*	*Scutia myrtina*
Capearis brevispina	*Hookinea mystax*	*Sexcorinacea lucophyrus*
Carissa spinarum	*Jasminum angustifolium*	*Solanum indicum*
Cassia auriculata	*Lepisandrus tetrophyla*	*Solanum trilobatum*
Cassia fistula	*Lucas aspera*	*Thalchus palcatus*
Cassia tora	*Maba buxifolia*	*Tinospora cordifolia*
Chemicyclia sapharia	*Gmelina asiatica*	*Trichosanthes cucumerica*
Gyrocarpus americanalis	*Manilkara hexandra*	*Tylophora asthamatica*
Cissus quadrangularis	*Maytenus emarginata*	*Volex scandens*
Cissus vitiginea	*Memecylon umbulatum*	*Walsura piscidia*
Clitoria ternate	*Mucuna prurita*	*Watakaka volublis*
Clarodendrum inerme	*Passiflora foetida*	*Xecronica lucoferrous*
Coccinia indica	*Pavetta indica*	*Zizyphus jujuba*
Crataeva religiosa	*Phoenix pusilla*	*Zizyphus oenoplia*
Crotolaria labitifolia	*Phyllanthus reticulatus*	
Crotolaria viscosa	*Phyllanthus microphylla*	
Dichrostachys cinerea		

Table 3 Plant densities in sampling plots

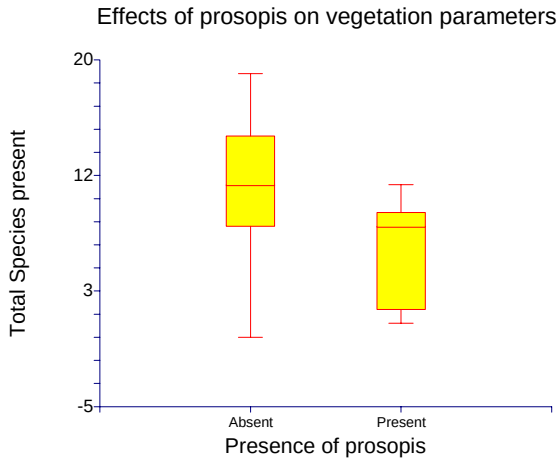
Plot No	Plot area (sq m)	Total Individuals	Total species	Total *Prosopis*	Total Density
1	155	27	11	8	0.17
2	213	46	11	10	0.22
3	100	36	8	1	0.36
4	100	16	9	1	0.16
5	100	0	0	0	0.00
6	100	58	16	0	0.58
7	100	0	0	0	0.00
8	100	16	8	5	0.16
9	100	34	11	0	0.34
10	69	14	5	1	0.20
11	209	89	19	0	0.43
12	41	20	7	0	0.49
13	100	21	7	7	0.21
14	96	14	7	0	0.15
15	100	11	1	11	0.11
16	100	36	9	2	0.36
17	100	6	1	6	0.06
18	100	37	9	1	0.37
19	364	10	1	10	0.03
20	100	43	15	0	0.43
21	113	31	14	0	0.27
22	108	41	10	0	0.38
23	100	37	9	0	0.37
24	100	41	16	0	0.41
25	100	53	12	0	0.53
26	100	44	12	0	0.44
27	100	35	10	0	0.35
28	100	35	11	0	0.35
29	100	61	11	0	0.61

Box plots are given below. There is a brief note on interpreting these in the methods section.

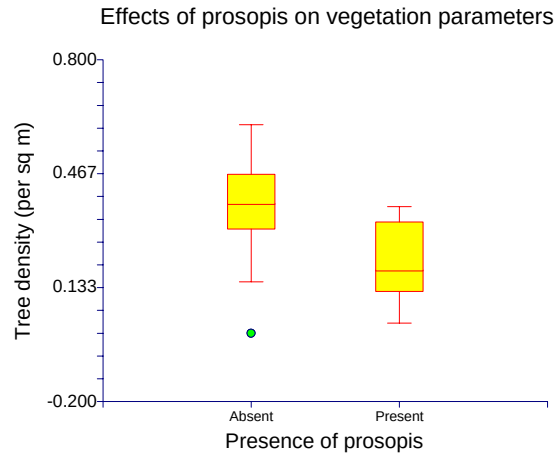
Graph 1: Box plot indicating fewer individuals in vegetation plots with Prosopis.

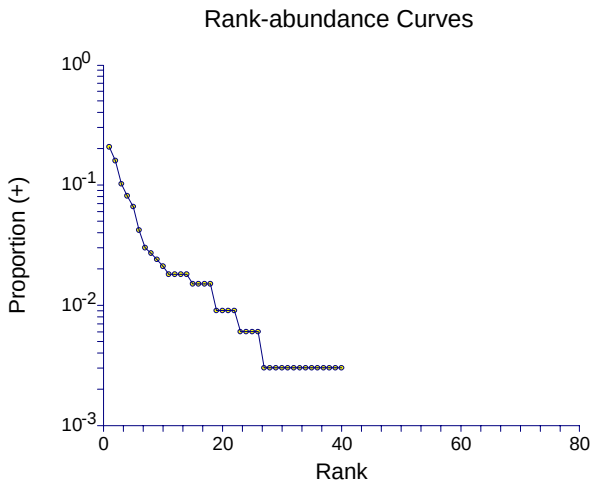


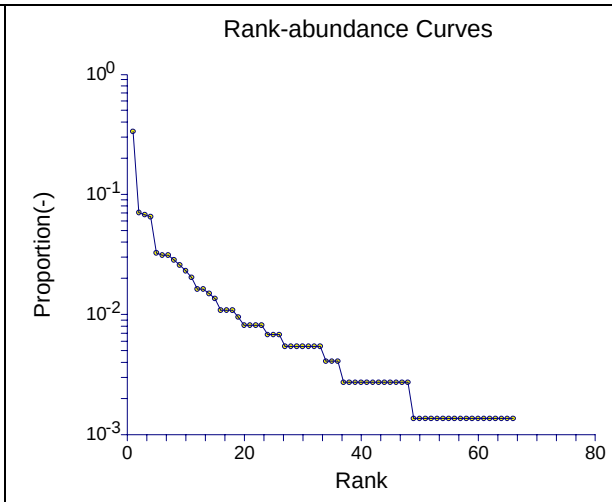
Graph 2: Box plot indicating higher species richness in plots lacking Prosopis.



Graph 3: Higher plant densities were encountered in vegetation plots with out Prosopis.







Graph 4: Ranks abundance curve indicating lower plant species richness and simpler community structure in plots with Prosopis

The graph on the left shows rank abundance in plots when *Prosopis* is present and that on the right shows rank abundance when *Prosopis* is absent.

It can be seen clearly that the rank-abundance curve where *Prosopis* is present tends to resemble the broken-stick model, implying a far simpler community structure than in the plots where Prosopis is absent. The plots also clearly indicate that species diversity is considerably higher in the plots where Prosopis is absent. The longer tail of the bottom curve also indicates that many more species are present.

The effects of Prosopis

It is relevant to go into a couple of the key landscape ecology consequences of Prosopis here. If *Prosopis* had merely invaded the open areas its diversity would be higher than TDEF, and not lower. Its presence is leading to the fragmentation of the TDEF habitat, large contiguous patches of TDEF are being converted into smaller patches. We may therefore expect the loss of species from these smaller patches. The less abundant species will be the first to disappear.

The form of fragmentation here is shredding. The *Prosopis* invades patches of vegetation (besides open spaces), and smothers the smaller species. It thus provides barriers to physical movements of animals as well.

An important aspect to bear in mind is that Prosopis has a lower Net primary productivity (NPP) than TDEF. This is obvious from comparing the vegetation classification with the NDVI images. It is spreading, as can be established from comparing the 1991 and 1999 images. Therefore it can be concluded that it is causing the reduction of NPP over the park.

Fauna

There is a great deal of existing literature on the fauna of Point Calimere and its surroundings. 257 species of birds have been recorded, of which 119 are water birds and 138 are land birds. Since this is already available with the Forest department the list has not been repeated here. However, the results of census and transects done by us are presented.

Objectives

- To enumerate the abundance of mammals found in the Park

- To study the impacts of *Prosopis* on distribution of birds

Methodology

To estimates the abundance of mammals line transect sampling method was used. A total of 8 transects was walked The map shows the location of these transects. Existing transects, marked by the Forest Department, were used and no additional transects were marked. Although traditionally and for logistic reasons transects are either straight lines or several segments of straight lines, in this case curves were used. To estimate the shortest distance from the transect to the animal location GPS locations of each sighting was noted down along with the sighting distance and sighting angle. Using these three we determined the actual location of the animal and then computed the shortest distance to the curved transect on a GIS platform. The data was then analysed using DISTANCE 4[6].

Bird counts were carried out in six locations within the park and one location in the Muthupet pet mangroves. A time based frequency approach as suggested by Freeman. S N. *et al*, 2003[7] was used rather than conventional counts

[6] Thomas, L., Laake, J.L., Strindberg, S., Marques, F.F.C., Buckland, S.T., Borchers, D.L., Anderson, D.R., Burnham, K.P., Hedley, S.L., and Pollard, J.H. 2002. Distance 4.0. Release 1 . Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. http://www.ruwpa.st-and.ac.uk/distance/

[7] Freeman. S. N, Pomeroy. D. E and H. Tushabe (2003). On the use of timed species counts to estimate avian abundance indicies in species rich communities. African Journal of Ecology 41: 337-348

Figure 4: Location of transects used to enumerate animal abundance.

Results and discussion

KEY FINDING: Line transect methods for animals, and point transects for birds are simple, easily taught techniques that require considerably less effort than the total count method used currently.

Mammals

Eight pre-existing transects covering the entire park were sampled during the study period. A total of about 85km was waked and over 350 animal clusters were sighted. Table 4 provides the details of the same. The density estimates (animals/sq km) are reported in Table 5.

Table 4: Details of the transect survey carried out in March, 2005

Transect No	Length (km)	No of sample	Black buck	Bonnet macaque	Chital	Cattle	Feral horse	Wild pig	Grand Total
2	0.7	4	9			17	4		30
6	2.1	5	70			16	10	1	97
10	2.1	7	92		1	15	3	1	112
14	2.9	5	11	3	1	4	5	6	30
16	1.8	5	4	5	3	3	5	2	22
18	2.2	1	1		1	2	1	1	6
19	1.6	5	7	2	5	6	6	8	34
22	3.4	7	14	1		6	1	5	27
Grand Total			208	11	11	69	35	24	358

Table 5: Density estimates for large mammals in Point Calimere.

			95% Interval	
Density Estimates (#/sq km)	**Mean**	**%CV**	**Lower**	**Upper**
Black buck	48.66	12.49	38.10	62.16
Cattle	13.64	20.79	9.08	20.49
Feral horse*	6.37	11.47	5.43	7.46
Bonnet macaque*	6.46	11.47	5.52	7.57
Wild pig*	3.09	11.47	2.64	3.62
Chital*	1.81	11.47	1.54	2.12

* Due to few sightings, the probability density function for all species combined was used to arrive at density estimates.

In terms of actual numbers, these would be multiplied by the area of the park (c.30 sq km of forest habitat), results of which have been presented in Table 6.

Table 6: Estimated number of individuals, estimates were arrived by multiplying estimated animal densities with the total area of the park. These estimates can be further refined by modelling the data using the program DISTANCE 4.

		95% C.L.	
	Average	Lower	Upper
Black buck	1460	1143	1865
Bonnet macaque*	194	165	227
Chital*	54	46	63
Cattle	409	272	615
Feral horse*	193	163	224
Wild pig*	93	79	109

The figures for blackbuck match those obtained in the annual census. A switch should be made to line transect methods here as it is both less energy intensive and easier to organise, as well as providing confidence limits to the data. In this study we just illustrate how line transects methods can be used for future monitoring. But we recommend that these methods be implemented with additional refinement. New transects of equal lengths and uniformly placed through out the park should be marked and the same walked annually. The added advantage of switching over to the design based sampling are; firstly, all habitats and areas of the park are more likely to be covered. This will certainly reduce the variance associated with the results to an extent. Second, information on range expansion and contraction will also be available thus providing inputs directly for management. Using the present data set, a simple encounter rate estimate (No. of animal clusters sighted / Km walked), preferred habitats for species is presented in table 4. It has been assumed that that the top 40% of encounter rates, cells that have been highlighted, represents preferred habitat. For example Blackbucks prefer areas around transects 2, 6 and 10. The assumption that the top 40% of encounter rates represents preferred habitat is questionable, only long term and periodic monitoring can yield sensible results. A Pearson's correlation matrix (Table 8) of the different species seen further strengthens the case of how different species utilise different habitats.

Table 7: Encounter rates of various species along each line transect. The highlighted cells indicate transects with the top 40% of the encounter rate values

Transect No	Black buck	Bonnet macaque	Chital	Cattle	Feral horse	Wild pig
2	3.21	0.00	0.00	6.07	1.43	0.00
6	6.67	0.00	0.00	1.52	0.95	0.10
10	6.26	0.00	0.07	1.02	0.20	0.07
14	0.76	0.21	0.07	0.28	0.34	0.41
16	0.44	0.56	0.33	0.33	0.56	0.22
18	0.45	0.00	0.45	0.91	0.45	0.45
19	0.88	0.25	0.63	0.75	0.75	1.00
22	0.59	0.04	0.00	0.25	0.04	0.21

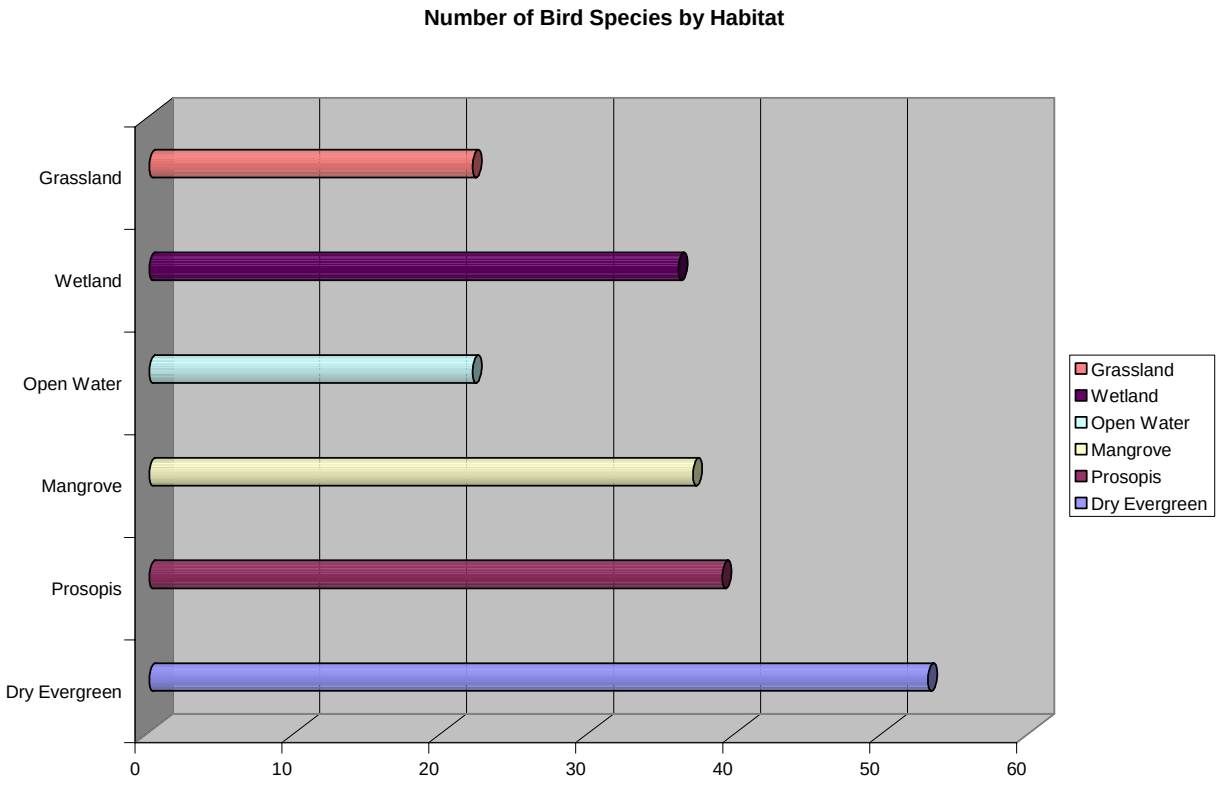
Table 8: Pearson Correlations of transect by transect correlations of species cluster sightings per transect.

	Blackbuck	Bonnet macaque	Chital	Cattle	Horse	Pig
Blackbuck	1.000	-0.597	-0.356	0.647	0.228	-0.486
Bonnet macaque		1.000	0.565	-0.861	-0.013	0.370
Chital			1.000	-0.538	0.138	0.580
Cattle				1.000	0.238	-0.725
Feral horse					1.000	-0.112
Pig						1.000

In this matrix, values range from –1 to +1. A value of +1 means a perfect correlation; -1 would indicate a negative correlation. The green highlights show the correlations between the occurrences of pig, chital and bonnet macaque. These tend to occupy similar habitats. The red highlight is the correlation between blackbuck and cattle, which also tend to occupy similar habitats. The presence of the cattle may result in competition with the blackbuck, and further studies on this are required. The yellow show that cattle and bonnet macaques tend to occupy different areas that were sampled.

Avifauna

A two-day census reported 115 species of birds, a significant percentage of the birds reported from the area. Some of the waders found here are only identifiable on land. The Greyheaded lapwing (Vanellus leucurus), a new species for the area, was reported during this study. A summary of the bird census results is given in the table below:

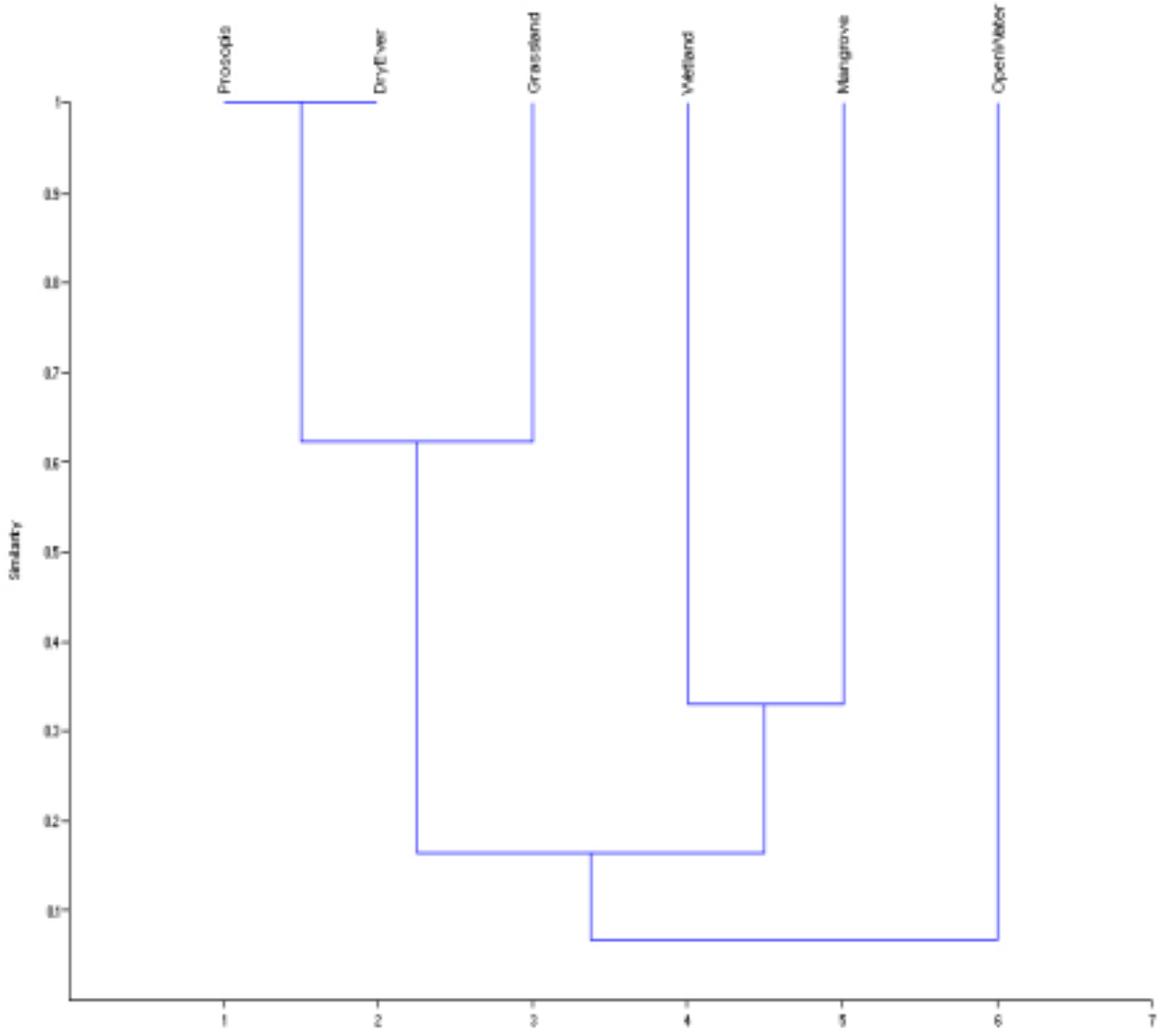


Graph 5: Number of bird sightings in different habitat types in Point Calimere

Based on the presence absence data the similarity of between different habitats types has been illustrated in figure 5. The dendrogram groups similar habitats together and the linkages between habitats indicates the related closeness between groups with respect to presence of birds. The similarity index ranges between 0-1 with zero being least similar and 1 being almost identical. Habitats are grouped together based on the number of common species they share. More the species they share, the closer they are. It can be seen that scrub and forest are quite similar while mangroves and wetlands are similar to each other. Open water habitats

seem to be quite distinct in the species which they share with other habitats. The links also indicate how different groups are related to each other. For example scrub and TDEF are similar the next group that shares similar birds with this group is grasslands. The value of 0.62 on the Y – axis can also be translated as, 62% of the birds recorded in TDEF, Prosopis and grasslands are common to all three habitats.

Figure 5: A dendrogram showing similarity between different habitats based on presence or absence of birds. Values on the Y-axis shows the similarity between different habitats, the length of each link indicates how each group is related to other groups.



Results indicate Prosopis and TDEF are similar in bird composition. A large number of birds may be common to both habitats but the results are biased due to sampling protocols that

were followed. Observers noted vegetation types available at each sampling point, but did not note the vegetation type the bird was observed on.

The bird study as emphasises on adapting better sampling techniques to monitor bird populations. Given the vast expanse of water counting and identifying all birds is difficult. Other than actual counts a time based, frequency of bird counts could also be used for monitoring bird populations, background material for the same has been included in the CD-ROM. When identifying birds is difficult, grouping them into the next higher taxon like the family or genus should be sufficient. Other important points that need to be considered during bird censuses are:

- MONITORING EFFORT: The time spent in the field should be carefully recorded. The effort put in would be one of the common yardsticks used to compare birds and habitats across years.

- HABITAT USE: The habitat use of birds needs to be monitored, and not merely bird populations themselves as the quality of the habitat is the prime focus. The added advantage of recording the habitat information along with bird counts allows one to monitor species habitat associations, a tool used to monitor changes in habitat.

- ALLOCATION OF EXPERTISE: People with good identification skills should be listing species and confirming identifications. It is easier to train people to count birds than it is to train them to critically distinguish similar looking birds.

- SAMPLING DESIGN: Point transects used for monitoring should be uniformly distributed through out the park. Given the salinity problem in the area, it is also required to collect water quality data at each sampling point. This will allow us to understand how salinity affects the distribution of birds. Also sampling the same points each year or on a seasonal basis will allow predictive modelling of bird distribution and populations which will provide inputs for protection of bird habitats.

Point Calimere, environs and Muthupet	Dry Evergreen	Prosopis and Scrub	Mangrove	Open Water	Wetland	Grassland
Brahminy Kite			P	P	P	
Pond Heron			P		P	
Whiskered Tern				P		
Large Egret			P		P	
Pied Kingfisher			P	P		
Collared Dove	P	P				P
Little Egret			P			
Bluetailed Bee-eater	P		P			
Rosy Pastor	P	P				
Spotted Dove	P	P	P			
Blyth's Reed Warbler	P	P				
Curlew					P	
Little Ringed Plover					P	P
Roseringed Parakeet	P		P			
Whitebreasted Kingfisher	P	P	P		P	
Brownheaded Gull						
Common Swallow			P	P	P	P
Golden Plover					P	
Green Sandpiper					P	
Greenshank					P	
Gullbilled Tern				P		
Little Tern				P		
Redvented Bulbul	P	P	P			
Small Green Bee-eater	P	P	P		P	
Blackbuck	P					P
Common Myna	P	P				
Common Redshank					P	
Common Sandpiper					P	
Jungle Crow	P	P	P			
Kentish Plover					P	P
Little Green Heron			P		P	
Painted Stork			P		P	
Palm Swift	P	P				P
Pintail duck				P		
Shoveller				P		
Greater Flamingo					P	
Grey Heron			P		P	
Grey Partridge	P	P				P
House Crow	P	P	P			
Little Cormorant			P	P		

Point Calimere, environs and Muthupet	Dry Evergreen	Prosopis and Scrub	Mangrove	Open Water	Wetland	Grassland
Redwattled Lapwing		P				
Reef Heron					P	
Terek Sandpiper					P	
Whitebreasted Waterhen	P	P	P			
Whitebrowed Bulbul	P	P	P			
Wigeon				P		
Ashy Swallow Shrike	P	P				P
Black Drongo	P	P	P			P
Blackheaded Gull				P		
Blackwinged Stilt					P	
Caspian Tern				P		
Iora	P	P				
Koel	P	P				
Little Stint					P	
Marsh Sandpiper					P	
Median Egret			P		P	
Pipits, all		P				P
Plaintive Cuckoo	P	P				
Small Greenbilled Malkoha	P	P				
Spotted Sandpiper					P	
Tree Pie	P	P				
Ashy Wren Warbler	P	P				
Ashycrowned Finch Lark		P				P
Baybacked Shrike	P	P				
Black Bittern			P			
Blackcaped Kingfisher			P			
Blue Rock Pigeon	P					P
Bush Lark		P				P
Cattle	P	P				P
Cattle Egret			P		P	P
Coppersmith	P					
Coucal	P	P	P			
Gargany				P		
Grey Pelican				P		
Horses						P
Jungle Babbler	P	P				
Jungle Myna	P					
Kestrel		P				P
Kora			P			
Magpie Robin	P					

Point Calimere, environs and Muthupet	Dry Evergreen	Prosopis and Scrub	Mangrove	Open Water	Wetland	Grassland
Marsh Harrier				P	P	
Montagu's Harrier					P	P
Mudskipper fish					P	
Openbill Stork					P	
Paradise Flycatcher	P		P			
Purple Sunbird	P	P	P			
Purplerumped Sunbird	P	P	P			
Skipper Butterflies			P	P		
Small Blue Kingfisher	P		P			
Spoonbill					P	
Tailor Bird	P	P				
UNIDENTIFIED	P	P	P	P	P	P
Whimbrel					P	
Whiteheaded Babbler	P	P				
Wood Sandpiper					P	
Brahminy Myna	P					
Brown Shrike	P					
Coot				P		
Cotton Teal				P		
Golden Oriole	P					
Greenish Leaf Warbler	P	P	P			
Grey Drongo	P					
Hoopoe	P	P				
House Sparrow	P					
Indian Roller	P	P				P
Indian Treepie	P					
Intermediate Egret			P		P	
Large Cormorant			P	P		
Large Pied Wagtail					P	P
Lesser Goldenbacked Woodpecker (call)	P					
Little Grebe				P		
Pariah Kite	P					
Spotbilled Pelican			P	P		
Spotted Owlet	P					
White-eyed Buzzard	P					P

Socio-economic surveys in the human habitations around the park to assess levels of dependence upon the park

Objectives

To access the level of dependency on forest by the communities living in and around the park.

Methodology

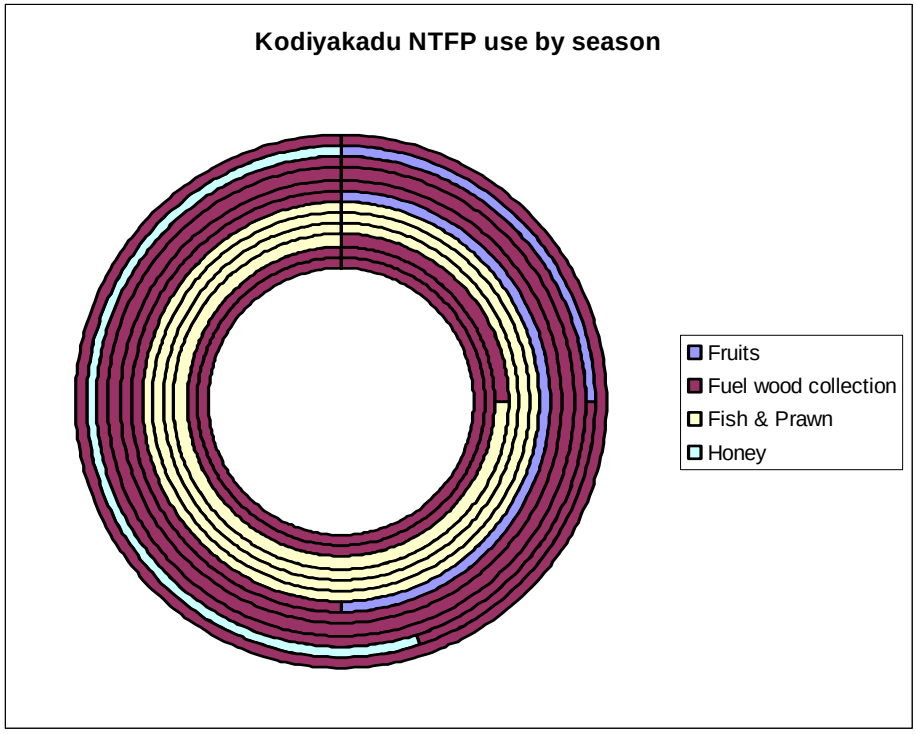
For this purpose five villages were chosen. They were Kodiyakaddu and Kodikkarai from Nagapatinam district and Athirampatinam, Maravakadu, and Manganakadu from Pudukottai district. Household surveys were carried out at all these sites. All information collected was on the basis of participatory exercises. Methods used for data collection include Participatory Rural Appraisals and focused group discussions. Data collected include a list of all activities with respect to forest resource exploitation and economic dependency of the community on these activities during different months of the year.

Results and discussion

KEY FINDING: Only the Ambalakar community of Kodiyakadu is dependent on the forest for fuelwood. They could be permitted to remove the Prosopis if the roots are removed as well, and a mechanism for doing this needs to be established.

Kodiyakadu is a small village, with the total number of households being 150. The main caste in that village is Ambalakar, an Most Backward community (90 houses) and Pandaram (60 houses). The main occupation of the people are wage labourers in salt pans, agriculture and fishing (all as labourers). Normally men get paid Rs.90 per day and women get paid Rs.45 per day. Some of them have leased agriculture land for tobacco cultivation (5 families).

Kodiyakadu residents also depend on nearby forest for fuel wood, fish, prawn, honey and various kinds of fruits, a secondary source of income.. The results from the Participatory Rural Appraisal exercise indicate that fuel wood is extracted from the forest and this activity is spread across seven months of the year. Four months of fruit collection occurs, and three months of fish and prawn catching activities occur in a year.



Graph 6: Indicates different activities spread across the year. Each ring represents a Tamil month, the outer most ring representing Chithirai and the innermost representing Punguni. Divisions in each ring represent an activities.

The graph above indicates the activity budgets across the year. Each concentric ring represents a month, with Chithirai being the outer most and Punguni being the inner most ring.

Kodiyakarai: Kodiyakarai residents do not depend on the forest for their secondary income. The main caste in this village is Vallar pillai, (250 houses), Muslims (50 houses), and Christian (1 house). The primary occupations of the people are agriculture (tobacco), fishing and as wage labourers in saltpans.

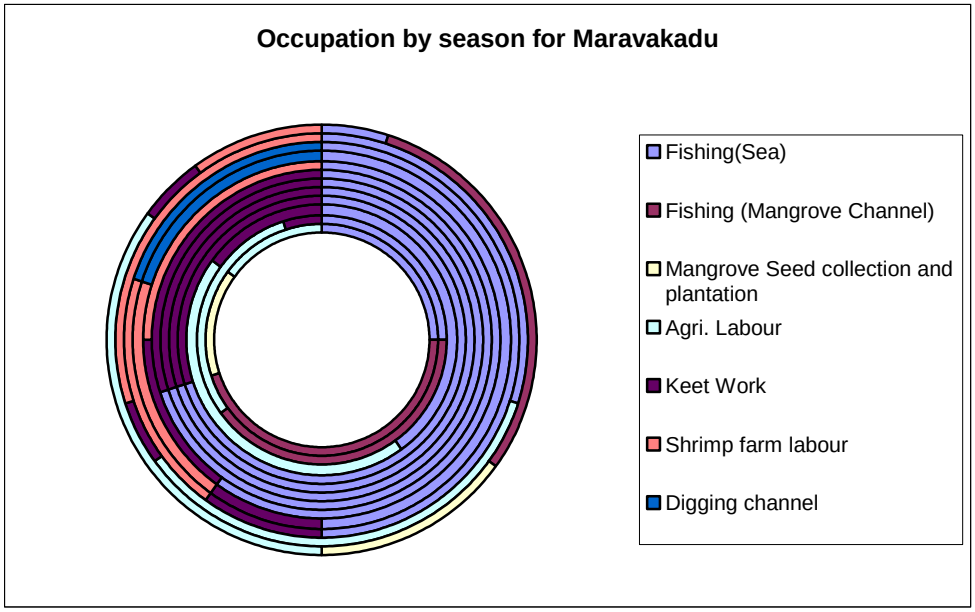
Athirampatinam is a big village, and has a population of around 25,000. The main castes in this village are Thevars, Ambalakarar, Konar and Muslims. People are engaged in various kinds of activities for their livelihood. These include agriculture, agricultural labour, fishing, and business. The main crop is paddy and coconut and the irrigation water source comes from the Nasuni river. The wage for agriculture labour in this village is Rs.75 for male and Rs.45 for female. Only 5 families are dependent on forest for mangroves seed collection and planting between November to February. These activities are carried out through the forest department for which they are paid Rs.100 per day per person. One person can collect 30 kg of mangrove seeds in a day and it takes two days to plant these.

Fuel wood collection is no longer taking place in this village. The villagers said that 7-8 years ago they used to collect fuel wood inside the mangrove forest, but it has stopped because of the heavy fines imposed by the forest department. Fuel wood is currently being purchased or collected from *Prosopis* trees. 40 families of Konar community live in this village and each family has approximately 25 cows. The families do not graze their cows in the mangrove forest.

Maravakadu: The main castes in this village are Ambalakarar and Thevar. The main occupations are agriculture, agricultural labour and fishing in the sea. The main crop is paddy and the irrigation water source comes from the Pattuvanachi River as well as from borewells. The wage for agriculture labour in this village is Rs.75 for male and Rs.45 for female. Maravakadu residents also depend on mangrove forest for fish, prawn and mangrove seed collection for their secondary income.

Fish and prawn catching activities in the mangrove channels takes place from November to January (3 months) and mangrove seed collection occurs between December and January. 5-6 Women groups which were formed by the M. S. Swaminathan Research Foundation are involved in the seed collection activities for which they get paid Rs.40/day. Women's group members also do free labour for one day to show their participation.

Fuel wood collection is no longer taking place in this village. The villagers said that 6 years ago they used to collect 1 bundle (15 kg/person) of fuel wood inside the mangrove forest and sell it for Rs.35, but have stopped it because of awareness created by M. S. Swaminathan Research Foundation. Nowadays coconut tree waste is purchased as an alternative to fuel wood.



Graph 7: Indicates different activities spread across the year. Each ring represents a month the outer most represents January and represents December. Divisions in each ring represent different activities.

ManganaKadu: Managanakadu is a small village, with the total number of households in the village being 150. The main castes are Ambalakarar and Konar. The main occupations of the people are agriculture, agricultural labour and fishing in the sea. The main crop is paddy and chenna. Like Maravakadu, Managanakadu residents also depend on mangroves forest for fish, prawns and mangrove seed collection for their secondary income. Fish and prawn catching activities in the mangrove channels take place in the months of November to January (3 months) and mangrove seed collection occurs in the months of February and March.

The Forest Department is currently executing channel works in the mangrove forest. For this 20 people from this village are employed as labour for digging channels In this village also fuel wood collection is no longer taking place. Fuel wood is currently being purchased or collected from *Prosopis* trees. There are 100 cows in this village, which are owned by the Konar community. These are not grazed in the mangrove forest.

Only communities living in Kodiyakadu seemed to depend on the forest produce for a secondary income. It needs to be noted that the bulk of the dependent community was Most Backward Community.

Key conclusions and recommendations

1. The presence of *Prosopis* correlates with a reduction in plant diversity. It is not clear yet whether the *Prosopis* invades open patches or replaces the vegetation in existing patches. This would be an interesting research topic, but does not need to be carried out as a priority. ***In any case its presence as an invasive alien species mandates its removal as a top priority***. The fuel wood requirements of the villagers of Kodiyakadu village can be met by allowing them to remove only *Prosopis*, provided they remove the roots as well. Thought may be given to contracting out *Prosopis* removal for charcoal manufacture as an alternate fuel material.

2. Bird censuses techniques need to adapt more scientific methods and emphasis on collecting habitat information along with birds counts is important.

3. Line transects for mammals give results similar to the total count method used. These also generate confidence limits to the data, making them more appropriate scientifically to use. This method should be utilized from now on, and the forest staff taught in its use.

4. Cattle may be competing with blackbuck for resources. However, this needs further study.

P.O. Box 28, Pondicherry 605 001, India
Tel. 91-413-2677204
feral@satyam.net.in
http://www.feralindia.org